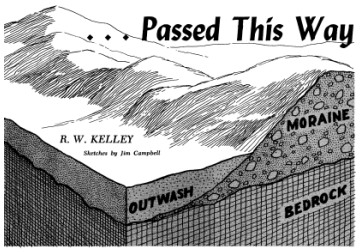
A GLACIER . . . Passed This Way



by

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Sketches by Jim Campbell

*Article originally published in *Michigan Conservation*, Special Great Lakes Issue, July-August 1960, Vol. XXIX, No. 4: Michigan Department of Conservation, Lansing, Michigan.

Just a few years ago, geologically speaking, a glacier passed this way, and that's why the Midwest has the Great Lakes.

How do we know a glacier passed this way? There are no glaciers within hundreds of miles of the Great Lakes today and the ice fields of North America are restricted to isolated mountainous areas of the northwest. But let's look at the evidence.

Studies of existing glaciers reveal the mechanics of ice movement and the nature of glacial deposits, so that comparisons with Michigan soils leave no doubt about their glacial origin.

One characteristic of glacial deposits is their variety of rock from widely scattered geographic areas. A good example is jasper conglomerate, a distinctive formation that outcrops only in Ontario north of Lake Huron. Yet pieces of it are scattered throughout eastern and central Michigan and elsewhere. Rock specimens from copper and iron formations of the Upper Peninsula are found in southwestern Michigan. Once it was believed that drifting icebergs carried these stones southward, hence the word "drift," the general term for all materials of glacial origin.

In non-glaciated regions, soils are derived from the weathering and decomposition of bedrock. The ancient bedrock formations in Michigan are generally covered with an average of 200 to 300 feet of drift — in places more than 1,200 feet.

Perhaps the most spectacular evidence of glacier movement over this region is in the ice-inflicted carvings and scorings in pre-glacial bedrock surfaces. They are most prominent on fresh bedrock surfaces, such as those exposed when the overburden is stripped in stone quarries. Frequently this "glacial pavement" is polished to a luster. Directional striae, or scratches, are always present. Flutings and grooves are common, some attaining depths of several feet. In places in the Upper Peninsula, small protruding irregularities in the old hard rock formations have been ice-sculptured and streamlined so they now appear to be "elephant backs" emerging from the soil.

Beginning about one million years ago climatic changes caused winters to lengthen in the northern part of the continent, and snowfall to increase but not melt in the short, cool summers. Great masses of ice accumulated over a period of years in the Hudson Bay region to form continental glaciers similar to the two-mile thick ice caps of Greenland and Antarctica. Altogether during the Great Ice Age, there were four or five major glacial advances. Interspersed between advances, climates moderated and soils developed. In Michigan, records of the early invasions have been obliterated or buried and we refer mostly to the last major advance and retreat of the glaciers, called the Wisconsin Stage.

Ice fanned out prominently from the Laurentian Highlands, east of Hudson Bay, and pushed southward to central Illinois, Indiana, and Ohio. The earlier stages had advanced as far south as the Ohio River. As the Wisconsin glacier moved forward, it enveloped the loose surface materials developed during the earlier stages. It also worked into breaches and around ledges in exposed bedrock and plucked off chunks. By the time it reached Michigan, the ice had incorporated an enormous volume of all kinds of rock debris.

Prior to glaciation, the Michigan area had been above sea level for some 200 million years. Since there is no record of deposition that can be correlated with deposits of this age in other adjacent areas, it is assumed that erosion was taking place. Probably great river systems, drained eastward, were eroding valleys in the areas now occupied by the individual basins of the Great Lakes. As the glacier approached the Great Lakes area, it took the course of least resistance, moved into the old river valleys, and divided into major lobes or ice tongues. As the lobes advanced, they deepened and broadened the valleys into basins.

The ice pushed over all of Michigan — the only state completely covered — and continued southward. Over-riding the drainage divide, it pressed downslope into the watershed of the old Mississippi River system. Its advance was finally halted short of the present Ohio River, when new climatic changes made cold give way to warmth.

Then started a grand retreat that gave rise to the most complex succession of lakes known to geologists. The retreat was not continuous, but was marked with many halts and occasional re-advances. Drift was released from the glacier in a rather "orderly disorder."

As long as the glacier margin was within the Mississippi drainage system, meltwaters were free to escape southward away from the ice front. When the ice retreated north across the old divide into the "Great Lakes" watershed, the melt-water no longer had an unrestrained flow southward. Surrounding moraines also became barriers. Figure 1 in the series of maps shows the position of the ice margin at this time.

As the ice lobes retreated into their originating basins, tremendous volumes of meltwater were ponded between the glacier front and the inner, or northerly, sides of an

earlier moraine. Thus were born the first ancestors of the Great Lakes, Lake Chicago and Lake Maumee.

The next major halt of the ice was at the site of the morainic system called the Lake Border (Fig. 2). Previously the glacier had retreated farther north only to readvance to this position. Lake Chicago in the Michigan basin and Lake Maumee in the Erie basin, therefore, had several different stages prior to those illustrated. Drainage was to the Mississippi.

Lake Chicago discharged through the Illinois River; Lake Maumee, through the glacial Fort Wayne-Wabash River most of the time, but for a while, it also flowed north through the Imlay outlet, across the "Thumb" (Fig. 5) to the old glacial Grand River that flowed west to Lake Chicago. During Lake Border time, Lake Chicago was all but forced out of its basin.

Another retreat freed much of the lake basins of glacial ice and Lake Arkona developed throughout the lowlands of the Erie, Huron, and Saginaw basins. It washed over the Lake Border moraine but continued to discharge across the glacial Grand River to Lake Chicago which was still draining to the Mississippi.

Then the last major ice readvance and long halt occurred. This was the time of the building of the most prominent morainic system of all — the Port Huron — which may be traced, with few breaks, from Minnesota to New York (Fig. 3). The advancing Huron lobe separated Lake Arkona into Lake Whittlesey, largest of the glacial lakes in southern Michigan, and Lake Saginaw, a shallow pond-like lake in the Saginaw lowlands where its shore lines are about 125 feet above, and some 45 to 50 miles inland from the shore lines of today. Lake Whittlesey discharged through the Ubly outlet (northern part of "Thumb", Fig. 3) into Lake Saginaw which discharged to Lake Chicago west across the glacial Grand River.

With further retreat of the glacier, water surfaces of Lakes Whittlesey and Saginaw merged to form Lake Wayne, but now the ice had uncovered a lower outlet across the Mohawk Valley in the vicinity of Rome, New York. The glacial Grand River outlet, being higher, was abandoned and for the first time, one of the early Great Lakes drained eastward to the Atlantic.

There was one last readvance, about 11,000 years ago, that again blocked the Mohawk outlet and raised the lake level about 20 feet to the next stage — Lake Warren — which restored discharge through the glacial Grand River to Lake Chicago, thence to the Mississippi. Further retreat re-opened the Mohawk outlet and, again, the glacial Grand River was abandoned during the stages of Lakes Grassmere and Lundy in the Huron-Erie basin. In the Superior basin, Lake Duluth was forming and it discharged south to the Mississippi.

After the ice had withdrawn completely from the Southern Peninsula, waters of the Michigan and Huron basins rose to form vast Lake Algonquin (Fig. 4) which discharged at Chicago and Port Huron. Lake Erie had formed earlier when the receding water level in that basin encountered resistant limestone in the Niagara River to create Niagara Falls. As the ice retreated in the Superior Basin, Lake Duluth grew in size and continued to discharge south.

It required about 2,500 years for the glacier to melt back from Fig. 4 to the position shown in Fig. 5. As the ice margin retreated northeastward across Ontario, the Port Huron outlet was abandoned and a succession of progressively lower eastern outlets were uncovered, resulting in a series of low water stages. The culmination was the extreme low water interval dating about 6,000 years ago (Fig. 5) when Lakes Chippewa and Stanley discharged via the North Bay outlet and the Ottawa River to the salty St. Lawrence Sea — an Atlantic embayment that encroached over the St. Lawrence lowlands into the Ontario basin. The North Bay outlet was near sea level. Discharge from Lake Chippewa cut the now submerged deep river gorge in the Straits of Mackinac.

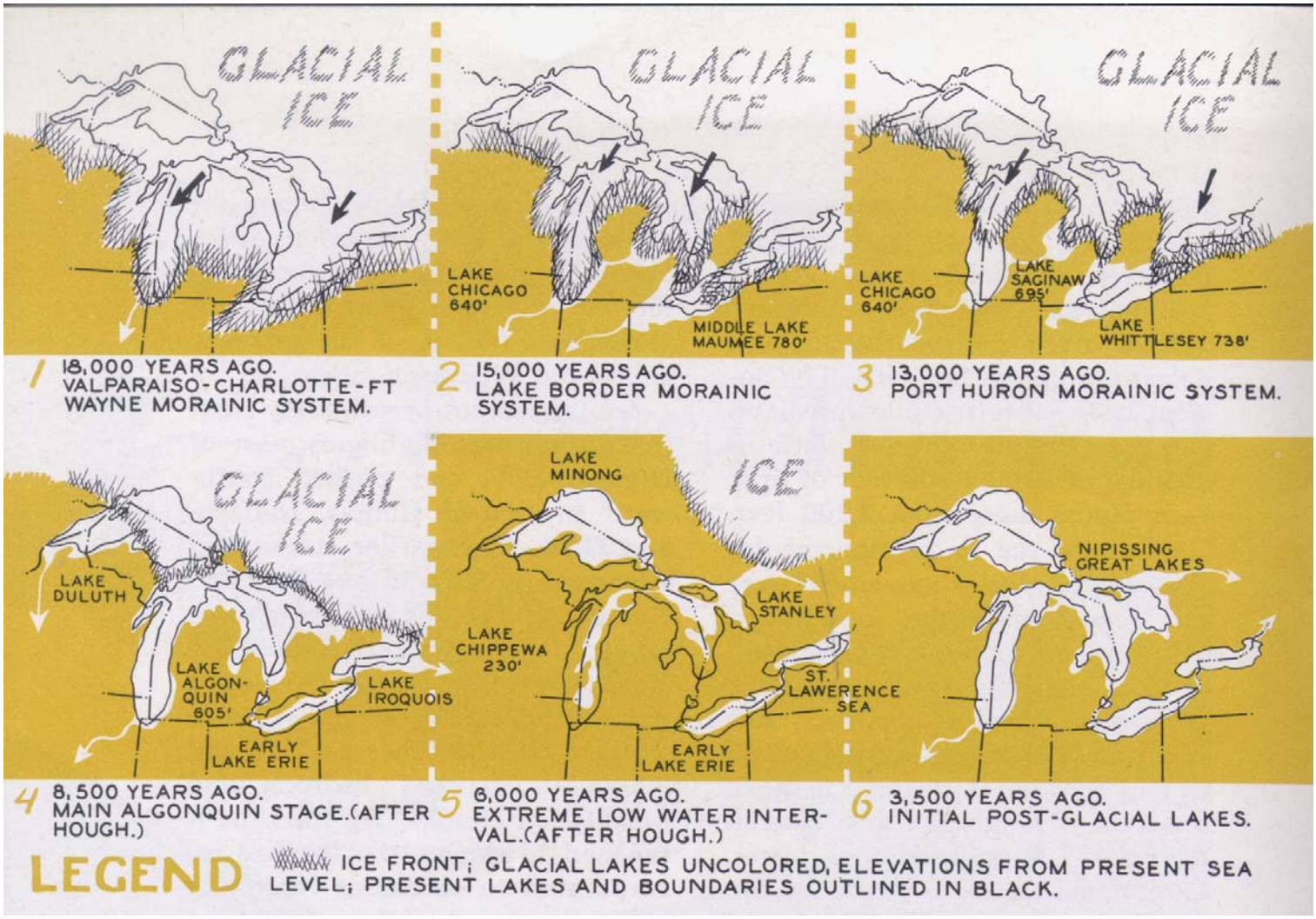
The Wisconsin glacier then permanently retired from the Great Lakes region, returning to the area where it first began to grow some 65,000 years ago. As the weight of the glacier was departing, the earth began to "spring" upward in what is called crustal rebound and the North Bay outlet rose gradually and continued to handle the discharge during the transition to the next and last glacial lake stage — the Nipissing Great Lakes — the largest of all the Great Lakes stages. Rebound also forced the St. Lawrence Sea to recede back to the Atlantic so that fresh waters entering the basin could form Lake Ontario. About 2,000 years elapsed before rainwaters eventually filled the upper lakes basins. The main Nipissing stage (Fig. 6) was attained when discharge was restored to both the Chicago and Port Huron outlets simultaneously with the North Bay outlet. These outlets provided stability that allowed Lake Nipissing to endure for about 1,000 years.

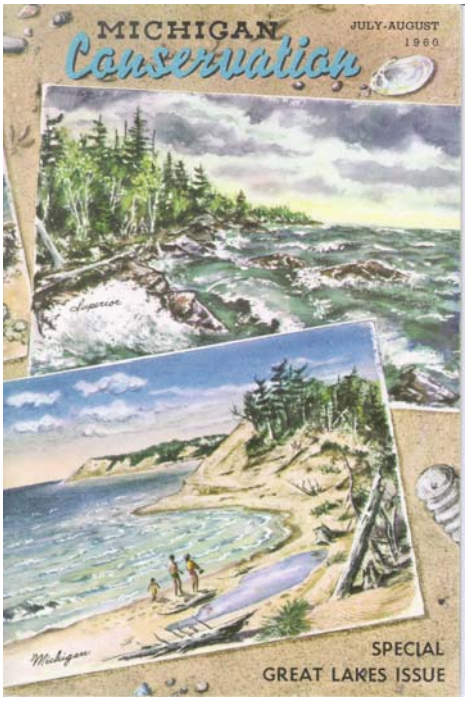
About 3,000 years ago Lake Nipissing began to wane. The North Bay outlet had been abandoned because of crustal rebound, thus forcing the full discharge through the Port Huron and Chicago outlets. The Chicago outlet, having a bedrock sill, resisted downcutting. The Port Huron outlet, being channeled in unconsolidated glacial drift, was subjected to steady downcutting. When the water surface dropped to the level of the sandstone sill in the St. Marys River, Lake Superior was born. When the lake level dropped below the Chicago outlet, Lakes Michigan and Huron were born.

Is another glacier due to pass this way?? — Could be!

When?? — I don't know — look me up in about 15,000 years!

Robert W. Kelley was born in Detroit in 1918 and received his Masterate in Geology from Wayne State University in 1950. He joined the Department in 1955 and is presently research geologist for the Geology Division.


GLACIAL ICE
1 18,000 YEARS AGO. VALPARAISO-CHARLOTTE-FT WAYNE MORAINIC SYSTEM.
LAKE CHICAGO 640'
MIDDLE LAKE MAUMEE 780'
2 15,000 YEARS AGO. LAKE BORDER MORAINIC SYSTEM.
LAKE CHICAGO 640'
LAKE SAGINAW 695'
LAKE WHITTLESEY 738'
3 13,000 YEARS AGO. PORT HURON MORAINIC SYSTEM.
LAKE DULUTH
LAKE ALGONQUIN 605'
LAKE IROQUOIS
EARLY LAKE ERIE
4 8,500 YEARS AGO. MAIN ALGONQUIN STAGE.(AFTER HOUGH.)
LAKE MINONG
LAKE CHIPPEWA 230'
LAKE STANLEY
ST. LAWERENCE SEA
EARLY LAKE ERIE
5 6,000 YEARS AGO. EXTREME LOW WATER INTERVAL.(AFTER HOUGH.)
NIPISSING GREAT LAKES
6 3,500 YEARS AGO. INITIAL POST-GLACIAL LAKES.
LEGEND
ICE FRONT; GLACIAL LAKES UNCOLORED, ELEVATIONS FROM PRESENT SEA LEVEL; PRESENT LAKES AND BOUNDARIES OUTLINED IN BLACK.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